1-1 Nets and Drawings for Visualizing Geometry

Common Core State Standards

Prepares for G-CO.A.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

MP 3, MP 4, MP 7

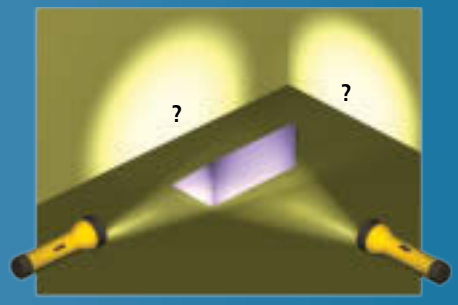
Objective To make nets and drawings of three-dimensional figures

Try to visualize what the figure might look like from different perspectives.

MATHEMATICAL PRACTICES

Getting Ready!

When you shine a flashlight on an object, you can see a shadow on the opposite wall. What shape would you expect the shadows in the diagram to have? Explain your reasoning.



Lesson Vocabulary

- net
- isometric drawing
- orthographic drawing

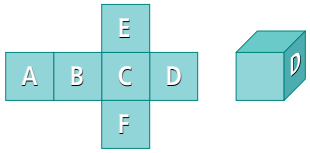
In the Solve It, you had to "see" the projection of one side of an object onto a flat surface. Visualizing figures is a key skill that you will develop in geometry.

Essential Understanding You can represent a three-dimensional object with a two-dimensional figure using special drawing techniques.

A **net** is a two-dimensional diagram that you can fold to form a three-dimensional figure. A net shows all of the surfaces of a figure in one view.

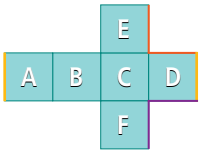
Problem 1 Identifying a Solid From a Net

The net at the right folds into the cube shown beside it. Which letters will be on the top and front of the cube?

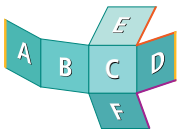


Think

How can you see the 3-D figure?
Visualize folding the net at the seams so that the edges join together. Track the letter positions by seeing one surface move in relation to another.



A, C, E, and F all share an edge with D when you fold the net, but only two of those sides are visible in the cube shown.



A wraps around and joins with D to become the back of the cube. B becomes the left side. F folds back to become the bottom.

E folds down to become the top of the cube. C becomes the front.

Got It? **1.** The net in Problem 1 folds into the cube shown at the right. Which letters will be on the top and right side of the cube?

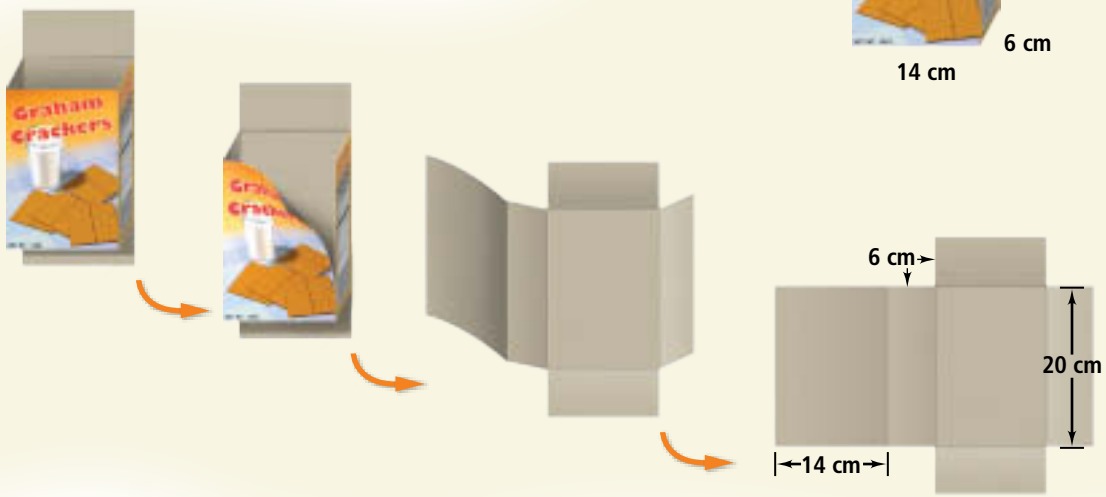
Packaging designers use nets to design boxes and other containers like the box in Problem 2.

Problem 2 Drawing a Net From a Solid STEM

Think

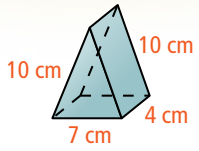
How can you see the net?
Visualize opening the top and bottom flaps of the box. Separate one of the side seams. Then unfold and flatten the box completely.

Package Design **What is a net for the graham cracker box to the right? Label the net with its dimensions.**



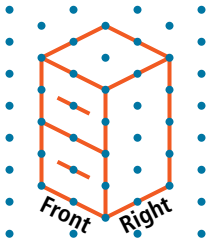
Got It? **2. a.** What is a net for the figure at the right? Label the net with its dimensions.

b. Reasoning Is there another possible net for the figure in part (a)? If so, draw it.



An **isometric drawing** shows a corner view of a three-dimensional figure. It allows you to see the top, front, and side of the figure. You can draw an isometric drawing on isometric dot paper. The simple drawing of a file cabinet at the right is an isometric drawing.

A net shows a three-dimensional figure as a folded-out flat surface. An isometric drawing shows a three-dimensional figure using slanted lines to represent depth.



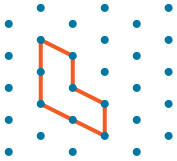
Problem 3 Isometric Drawing

Plan

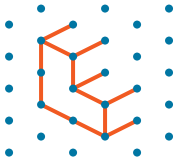
Is there more than one way to make an isometric drawing?
Yes. You can start with any edge of the structure. Use that edge as a reference to draw the other edges.

What is an isometric drawing of the cube structure at the right?

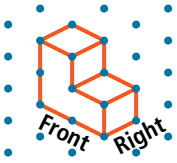
Step 1
Draw the front edges.



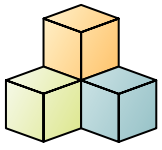
Step 2
Draw the right edges.



Step 3
Draw the back edges.



Got It? **3.** What is an isometric drawing of this cube structure?



An **orthographic drawing** is another way to represent a three-dimensional figure. An orthographic drawing shows three separate views: a top view, a front view, and a right-side view.

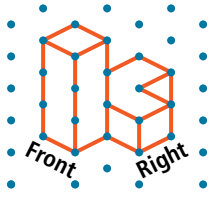
Although an orthographic drawing may take more time to analyze, it provides unique information about the shape of a structure.

Problem 4 Orthographic Drawing

Plan

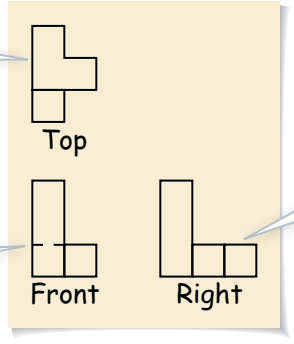
How can you determine the three views?
Rotate the structure in your head so that you can "see" each of the three sides straight on.

What is the orthographic drawing for the isometric drawing at the right?



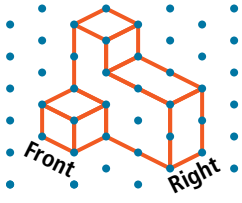
Solid lines show visible edges.

Dashed lines show hidden edges.



An isometric drawing shows the same three views.

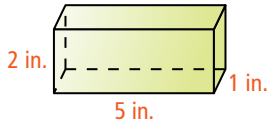
Got It? **4.** What is the orthographic drawing for this isometric drawing?



Lesson Check

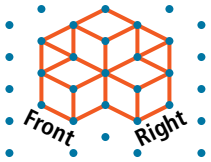
Do you know HOW?

1. What is a net for the figure below? Label the net with its dimensions.



2. What is an isometric drawing of the cube structure?

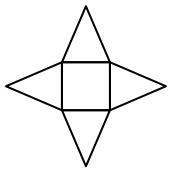
3. What is the orthographic drawing of the isometric drawing at the right? Assume there are no hidden cubes.



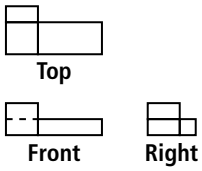
Do you UNDERSTAND? MATHEMATICAL PRACTICES

4. Vocabulary Tell whether each drawing is *isometric*, *orthographic*, a *net*, or *none*.

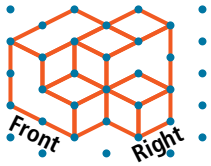
a.



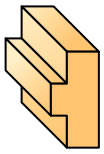
b.



c.



d.



5. Compare and Contrast What are the differences and similarities between an isometric drawing and an orthographic drawing? Explain.

Practice and Problem-Solving Exercises MATHEMATICAL PRACTICES

A Practice

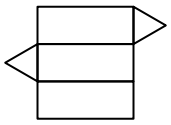
Match each three-dimensional figure with its net. See Problem 1.

6.

7.

8.

A.



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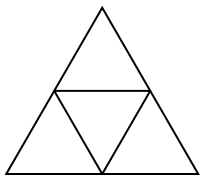

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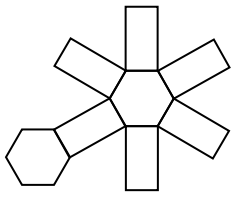
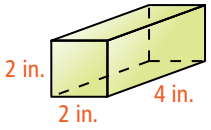


Draw a net for each figure. Label the net with its dimensions. See Problem 2.

9.



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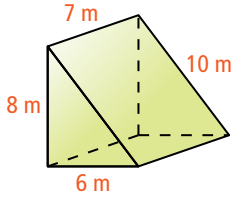

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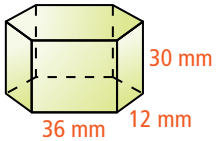
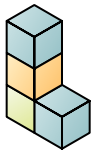
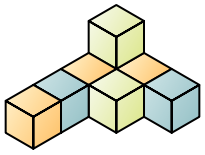
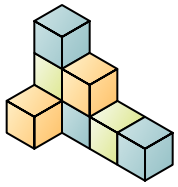
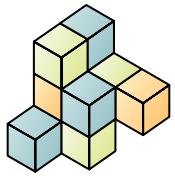


Make an isometric drawing of each cube structure on isometric dot paper. See Problem 3.

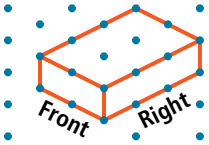
12. 

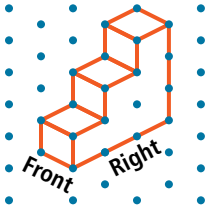
13. 

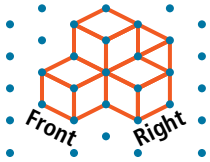
14. 

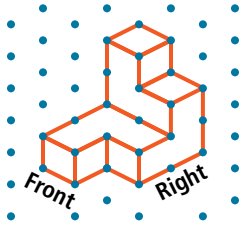
15. 

For each isometric drawing, make an orthographic drawing. Assume there are no hidden cubes. See Problem 4.

16. 

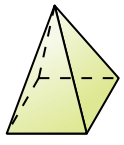
17. 

18. 

19. 

B Apply

20. **Multiple Representations** There are eight different nets for the solid shown at the right. Draw as many of them as you can. (*Hint*: Two nets are the same if you can rotate or flip one to match the other.)



21. **a. Open-Ended** Make an isometric drawing of a structure that you can build using 8 cubes.
b. Make an orthographic drawing of this structure.

22. **Think About a Plan** Draw a net of the can at the right.
- What shape are the top and bottom of the can?
- If you uncurl the body of the can, what shape do you get?

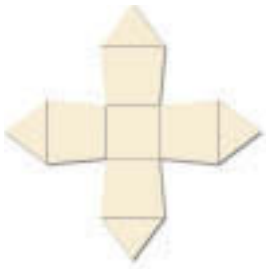
23. **History** In 1525, German printmaker Albrecht Dürer first used the word *net* to describe a printed pattern that folds up into a three-dimensional shape. Why do you think he chose to use the word *net*?

STEM Manufacturing **Match the package with its net.**

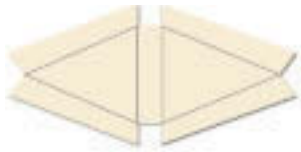
24. 

25. 

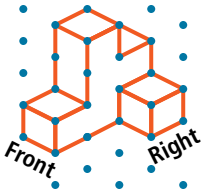
26. 

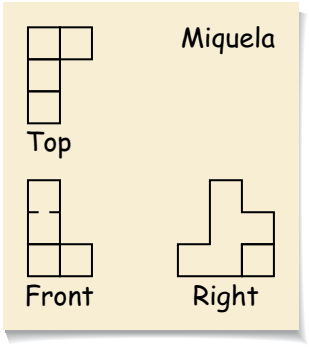
A. 

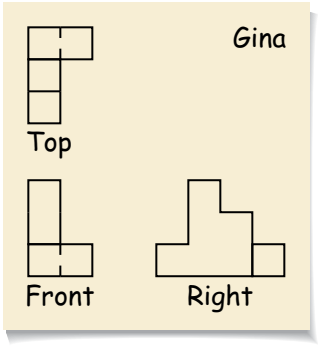
B. 

C. 

27. Error Analysis Miquela and Gina drew orthographic drawings for the cube structure at the right. Who is correct?

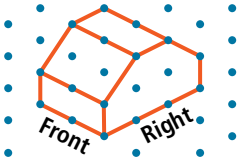






Make an orthographic drawing for each isometric drawing.

28.



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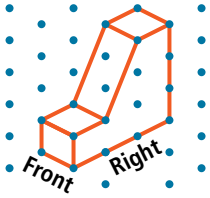
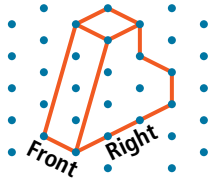


30.



31. Fort Use the diagram of the fort at the right.

a. Make an isometric drawing of the fort.

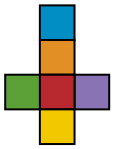
b. Make an orthographic drawing of the fort.

STEM **32. Aerial Photography** Another perspective in aerial photography is the "bird's-eye view," which shows an object from directly overhead. What type of drawing that you have studied in this lesson is a bird's-eye view?

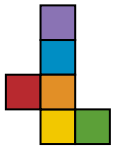
33. Writing Photographs of buildings are typically not taken from a bird's-eye view. Describe a situation in which you would want a photo showing a bird's-eye view.

Visualization Think about how each net can be folded to form a cube. What is the color of the face that will be opposite the red face?

34.



35.



36.

37.

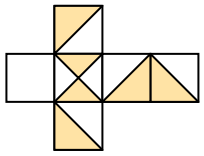
38. Multiple Representations There are 11 different nets for a cube. Four of them are shown above.

a. Draw the other seven nets.

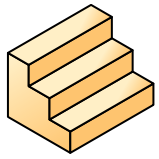
b. Writing Suppose you want to make 100 cubes for an art project. Which of the 11 nets would you use? Explain why.

Challenge

39. The net at the right folds into a cube. Sketch the cube so that its front face is shaded as shown below.

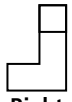


40. Architecture What does the net of the staircase shown look like? Draw the net. (*Hint*: Visualize stretching the stairs out flat.)



41. A hexomino is a two-dimensional figure formed with six squares. Each square shares at least one side with another square. The 11 nets of a cube that you found in Exercise 38 are hexominoes. Draw as many of the remaining 24 hexominoes as you can.

42. Visualization Use the orthographic drawing at the right.

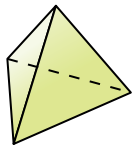


a. Make an isometric drawing of the structure.
b. Make an isometric drawing of the structure from part (a) after it has been turned on its base 90° counterclockwise.
c. Make an orthographic drawing of the structure from part (b).
d. Turn the structure from part (a) 180°. Repeat parts (b) and (c).

Standardized Test Prep

SAT/ACT

43. How many possible nets does the solid at the right have?



(A) 1 (B) 2 (C) 3 (D) 4

44. Solve $10a - 5b = 25$ for b.

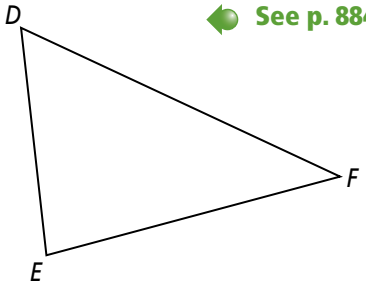
(F) $b = 10a + 25$ (G) $b = 10a - 25$ (H) $b = 2a + 5$ (I) $b = 2a - 5$

Short Response

45. Graph the equation $x + 2y = -3$. Label the x- and y-intercepts.

Mixed Review

For Exercises 46 and 47, use the diagram at the right.



See p. 884.

46. Measure DE and EF to the nearest millimeter.

47. Measure each angle to the nearest degree.

48. Draw a triangle that has sides of length 6 cm and 5 cm with a 90° angle between those two sides.

Get Ready! **To prepare for Lesson 1-2, do Exercises 49–51.**

Coordinate Geometry **Graph the points on the coordinate plane.**

See p. 893.

49. $(0, 0), (2, 2), (0, 3)$ **50.** $(1, 2), (-4, 3), (-5, 0)$ **51.** $(-4, -5), (0, -1), (3, -2)$